Traffic Engineering Conference 2011

99W Active Corridor Management

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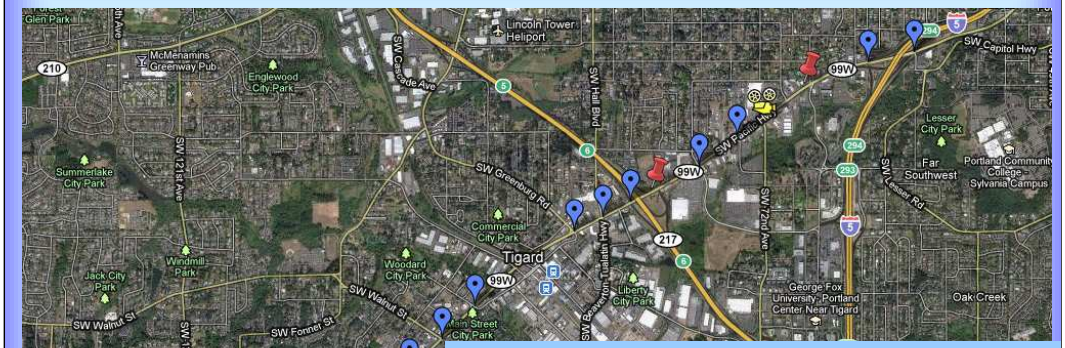
Presentation Outline

- Project and location background
  - Goals
  - Project elements
  - Evaluation process
- Advanced features description
- TransSuite demonstration
- Preliminary results
- Lessons learned
- Next Steps



Project Traffic Signals

I-5 NB / 60th Ave	Johnson Rd / Main St
I-5 SB / 64th Ave	Walnut St
68th Pkwy / 69th Ave	Garrett St
72nd Ave	Park St
74th Ave	Tigard Shopping Center
78th Ave / Dartmouth St	McDonald St / Gaarde
217 NB	Canterbury Lane
217 SB	Bull Mountain Rd
Hall Blvd	Beef Bend Rd
Greenburg Rd / Main St	Royalty Parkway
	Durham Rd

Location & highway/traffic characteristics

- Statewide highway
- National Highway System designated freight route.
- Major connection between downtown Portland and Sherwood (as well as further points south) while still needing to serve heavy local side street volumes

99W Corridor Characteristics

- Congested suburban corridor
  - 45,000 vehicles per day at the south end
  - 54,000 vehicles per day at the north end
- Built out with numerous accesses
- Tri-Met frequent service route
- Closely spaced intersections
  - 21 intersections in a 4.25 mile section
- Traffic Signal Timing last updated in 1998
- Signal technology approximately 20-30 years old

Traffic increases in the weekday AM peak hour and unlike other commuter routes, stays relatively constant throughout the day.

Frequent service route for transit and fairly high bike/ped volumes especially within the north section of the corridor.

Project need

This segment of OR99W has been and continues to be a bottleneck in the Portland regional transportation system.

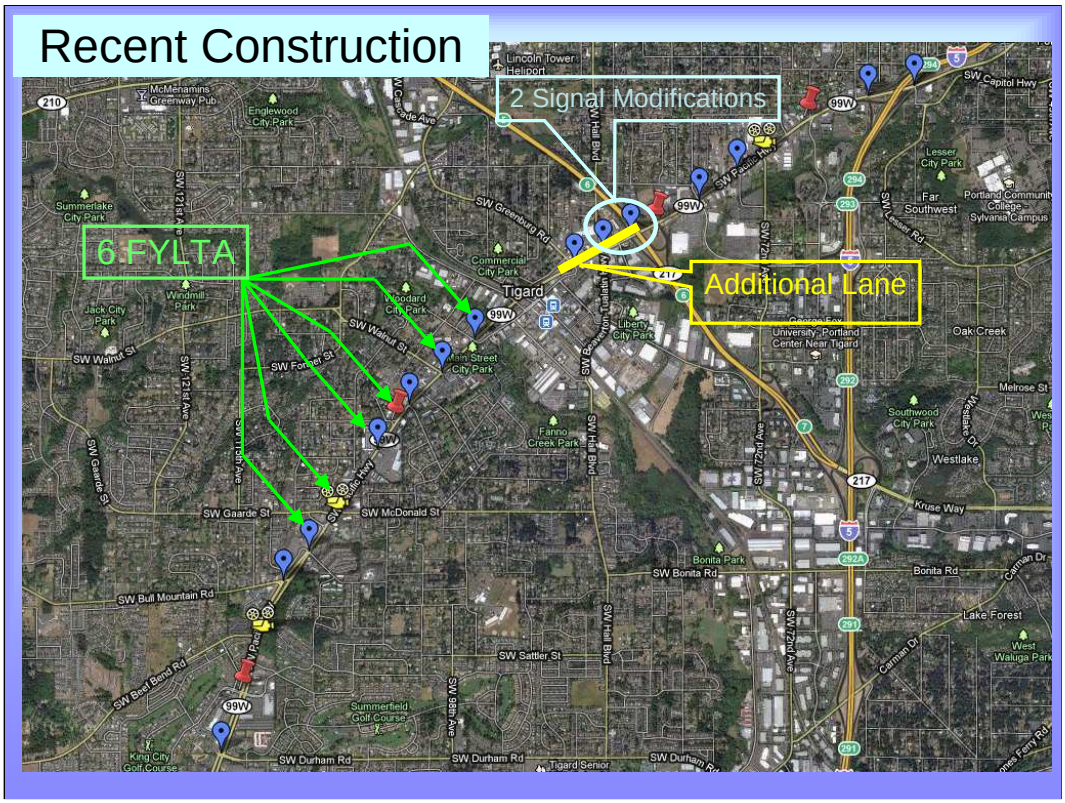
The Tigard 99W Improvement and Management Plan that was undertaken by a consultant team for both ODOT and City of Tigard determined that capacity improvements to add through lanes in both directions on 99W would be cost prohibitive and negatively impact adjacent properties throughout the corridor.

Latent demand would use up the additional capacity if lanes were added

Transportation system management was the chosen strategy for this corridor and maximizing the efficiency of the traffic signals is key to that plan. Other elements such as access management, improved bike/ped facilities, and improved transit service are also key components that are being or will be pursued through other projects that will complement this one.

ITS Grant

- Project funded through ODOT Innovative Grant Program
- $586,000 grant plus $50,000 match in staff time (both ODOT and City of Tigard)



99W @ Hall/Greenburg – Washington County project to add 3rd northbound lane, turn lanes on side streets, rebuild signals, etc.

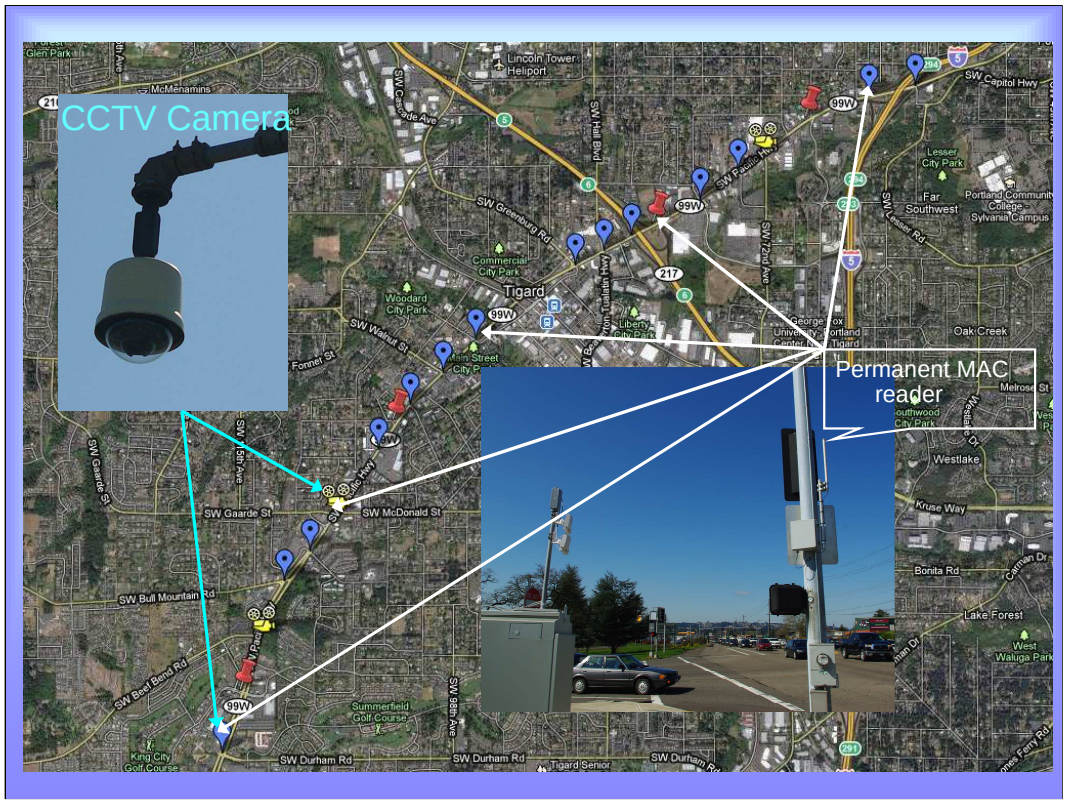
Flashing yellow arrows installed by Washington County at 6 intersections within the study area

Project Goals

- Reduce corridor travel times
- Reduce delay and queues, particularly on minor movements
- Better response to variations in traffic
- Improved system monitoring
- Advancing the state of signal timing practice in Oregon

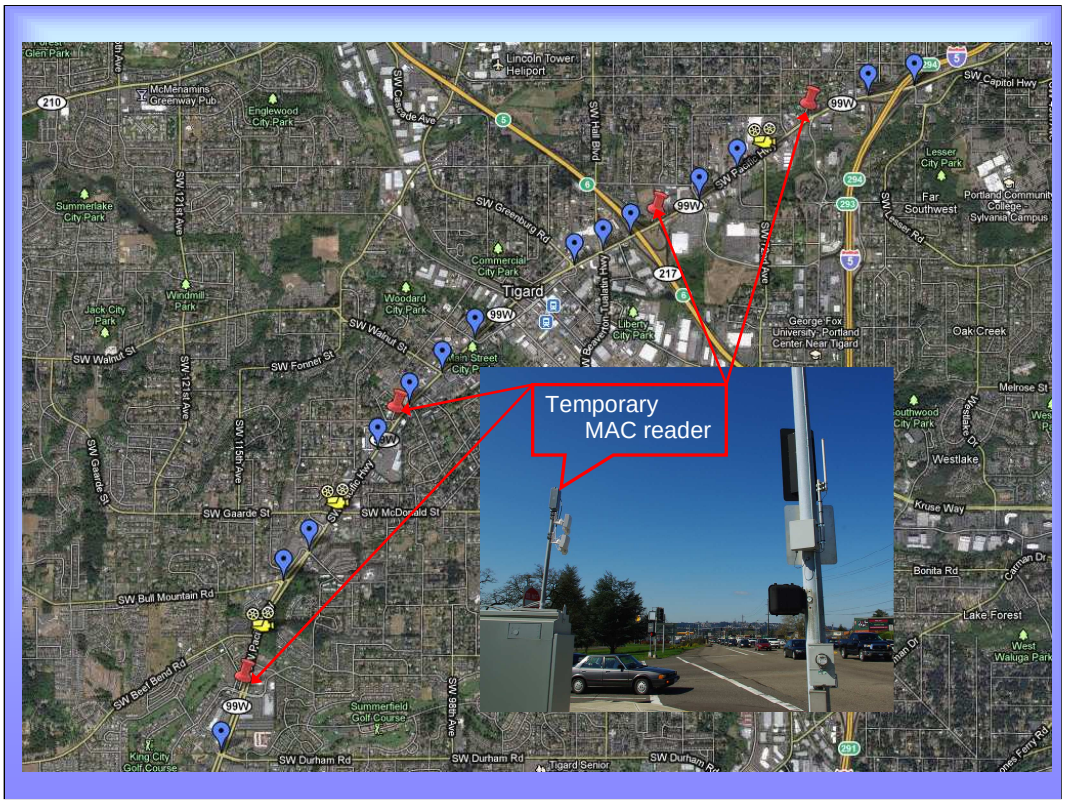
Goals for the Project (what we hope to accomplish)

- Reduce travel time through the corridor
  - This can be done with conventional signal timing, which is where we started
- Reduce delay and queues, particularly on minor movements
  - This is where Voyage, the new software running the controllers, really shines
- Better response to variations in traffic peaks
  - Traffic Responsive features can modify the signal timing to respond effectively to traffic as it fluctuates over an hour, a day, a week
- Improved system monitoring
  - More reliable and constant communication as well as new detailed monitoring tools
- Advancing the state of signal timing practice in Oregon
  - Across Oregon, in many jurisdictions, we have been using this technology, yet haven't had the time to put it through its paces. This project allowed us to better learn the technology and evaluate if it can really do what they say it can.



Project elements (what did project do)

- Equipment – while the focus was timing, there was also some permanent hardware installed
  - 2 full motion cameras
  - 4 permanent MAC readers – these devices use cell phone signals to track travel time



4 temporary MAC readers used for travel time evaluation

Project Elements

- Signal Cabinets
- Model 2070L Traffic Signal Controllers
- NWSVoyage firmware
- Modern Signal Communications
- TransSuite Communications software

New signal cabinets at several locations

Model 2070L controllers at 21 locations

replacing 20-30 year old technology

with NWSVoyage firmware

Communication gear

from dial-up modems to Ethernet

includes equipment at each location and,

central communications software (TransSuite) to bring it all together

Timing by ODOT

Evaluation by Kittelson

Study and Evaluation

Evaluation Tools

- Travel time studies using MAC readers
- Queue studies using video
- Evaluation tools within Voyage

Evaluation tools

Travel time studies using MAC readers

data collected for about two months

Queue studies using video

peak and offpeak periods observed at select intersections

Evaluation tools within Voyage

such as arrival on green graphs

Study and Evaluation

Evaluation Stages

1. Mimic existing technology
2. Optimize timing plans
3. Implement advanced features

Different phases of the evaluation

- Mimic Existing Technology
  - This step was done after the construction projects were completed
  - We put in the new controllers with the old timing primarily so that we could use the new evaluation tools
- Optimize Coordination Plans
  - get the timing as good as it can be with conventional methods
- Implement Advanced Features
  - “Advanced” = essentially anything Voyage can do that the old firmware couldn’t

Available Advanced Features

- ***Actuated Coordination***
- Auto Permissive Min Green
- Conditional Service
- ***Coord Late Left Turn***
- Coord Walk Rest
- Detector Fail Monitoring
- Detector Modes
- Dynamic FYLTA
- ***Dynamic Phase Length***
- ***Dynamic Phase Reversal***
- ***Fastway Offset Seeking***
- Late Ped / Conditional Ped
- ***Max Plans***
- ***Not Ped Overlap***
- Not Ped Ped Overlap
- Ped Overlap
- ***Ped Override Mode***
- Platoon Progression
- Preempt Recovery
- Red Extension
- ***Repeat Phase Service***
- Split Variant Operation
- ***Splits***
- Transit Priority
- Truck Priority
- ***Variable Max Extension***
- ***Zero Mode***
- Soft Recall

As you can see, we did not use all of the features available although we are interested in trying most if not all of them at some point. We used the ones we did because they were the most unilaterally applicable, the existing equipment would support the features, etc. We did not use some features such as transit and truck priority because those features would require additional detection equipment that this project did not include.

Advanced Features Used

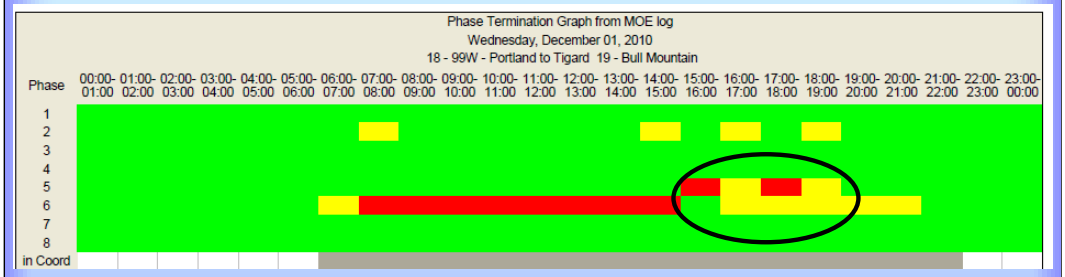
- **Actuated Coordination**
  - Nearly all intersections
- **Coord Late Left Turn**
  - 68th Ave
  - Hall Blvd
  - Greenburg
  - Bull Mountain
  - Beef Bend
- **Dynamic Phase Length**
  - Nearly all intersections
- **Dynamic Phase Reversal**
  - 74th Ave
  - 78th/Dartmouth
  - McDonald/Gaarde
  - Royalty Parkway
- **Fastway Offset Seeking**
  - All intersections
- **Max Plans**
  - All Intersections
- **Not Ped Overlap**
  - Hall Blvd
  - Greenburg
- **Ped Override Mode**
  - All intersections
- **Repeat Phase Service**
  - 68th Ave
  - 74th Ave
  - Park St
  - Tigard East Shopping Center
  - Canterbury Lane
  - Beef Bend Rd
- **Variable Max Extension**
  - 74th Ave
- **Splits**
  - All Intersections
- **Zero Mode**
  - SMS at nearly all intersections
  - EMS at Beef Bend Rd

Coord Late Left Turn

What do drivers notice

- Both left turns start together, then go to mainline throughs. If there's a gap, one left turn comes up again before going to side street
- 120 second cycle, side street can get 40-55 seconds of green (which means the left turn waits that long)

Coord Late Left Turn



- In the morning and early afternoon, the NB through (phase 6) uses its maximum green
- In the evening, phase 6 uses less time and the SB Left (phase 5) uses its maximum green time

Decision Criteria

- Programming requirements – mainly geometry
- Use the Measure of Effectiveness log (MOE) log to look for gaps (light traffic on mainline through) **and** demand on left turn
  - In the morning and early afternoon, the NB through (phase 6) uses its maximum green
  - Red on the graph shows vehicles frequently getting stopped
  - In the evening, phase 6 uses less time and the SB Left (phase 5) uses its maximum green time
  - Therefore, use Coord Late Left on phase 5 in the evening
- Maintain progression – don’t cut off platoons of vehicles

Coord Late Left Turn

Benefits

- Reduces delay for left-turners without impacting through traffic
- Can prevent blockages to the through lane

Drawbacks

- May violate driver expectancy
- May be a short second green

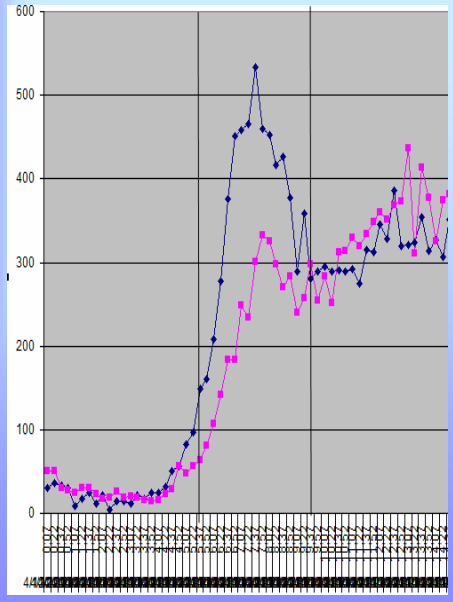
Benefits

- reduces delay for left-turn while minimizing impact on through (by using otherwise unused time)
- Can clear short turn pockets, preventing through lane blockages

Drawbacks

- Other left turn or side streets may think they've been skipped (though no complaints yet!)
- Second green can be very short if the gap comes late. Can be mitigated by proper programming

Repeat Phase Service



- Protects a set amount of green time on 99W
- Allows minor movements to re-serve if there is no traffic
- Useful when traffic peaks sharply

What do drivers notice

Protects a set amount of green time on 99W

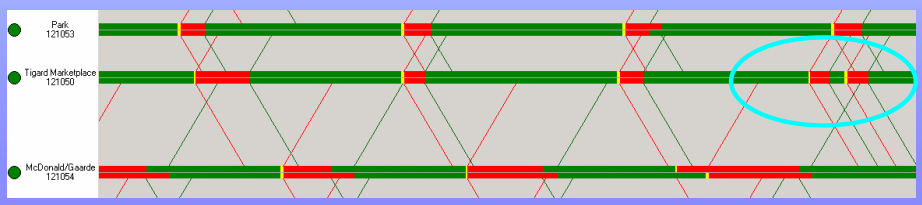
Allows minor movements to re-serve if there is no traffic

Useful when traffic peaks sharply

Timing plans are developed for the highest volume in a time period, but the rest of the period may not need as much green

Repeat Phase Service

- Useful for low-volume signals in the system
- Not much programming, just turn it on
- After implementation, use evaluation tools to determine effectiveness



Repeat Phase Service

Benefits

- Easy to program
- Reduces needless delay on minor movements when mainline has little traffic

Drawbacks

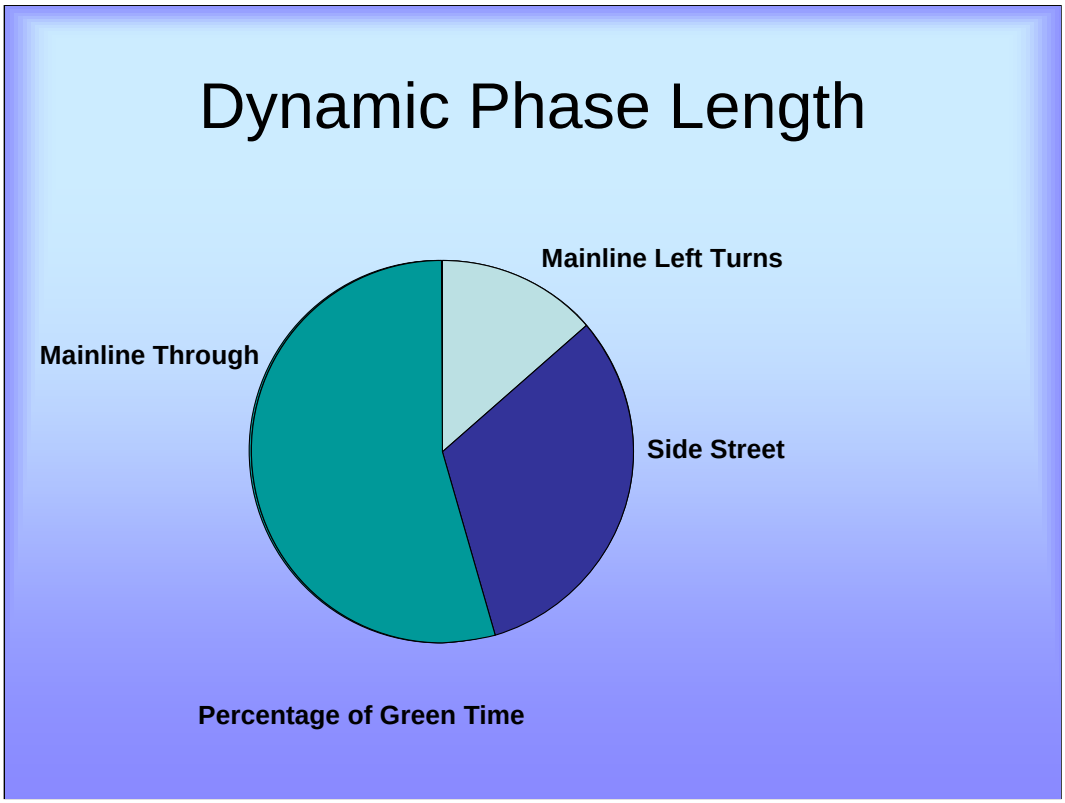
- May violate driver expectancy

Benefits

- Easy to program
- Just turn it on. If there's time to bring up phases again, it will. Otherwise, will behave as normal.
- Reduces needless delay on minor movements when mainline has little traffic

Drawbacks

- Driver expectancy
- May serve some movements once per cycle and others twice per cycle, leading some to feel they've been skipped
- Some movements will never be re-served based on placement within the cycle



What do drivers notice – not much. If a certain direction has heavy demand, then the controller will allocate additional time to that movement. This is determined for each cycle based on detection.

Decision Criteria - We turned this on everywhere within the corridor and let the controllers manage themselves.

Dynamic Phase Length

Benefits

- Allocates green time to direction that needs it at that time
- Utilizes cycle inefficiencies

Drawbacks

- Improper programming can cause movements to be skipped
- Bad detection can give too much time to a particular movement

Benefits/Drawbacks

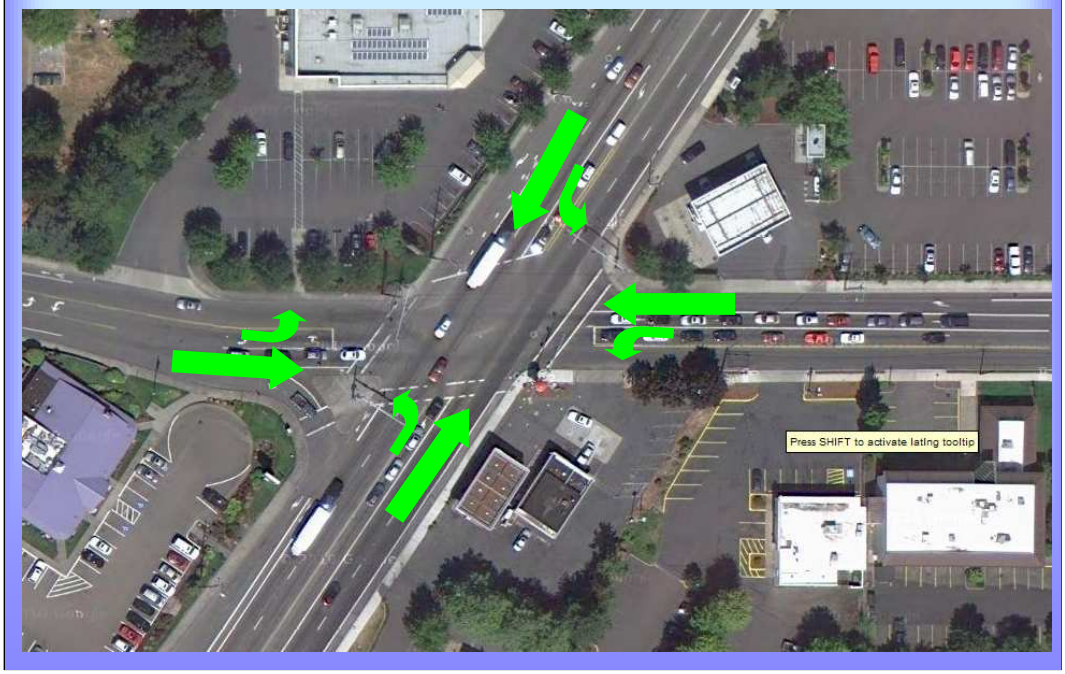
The expected benefit of Dynamic Phase Length is to reallocate extra green time more effectively and to reduce queue lengths, even in highly congested periods.

This is one of the most traffic responsive features that we used on this project

Cannot be used where there is bad detection or constrained cycles.

Has been shown to cause coord fault where one or more phases with demand is skipped and then the signal runs free for a cycle.

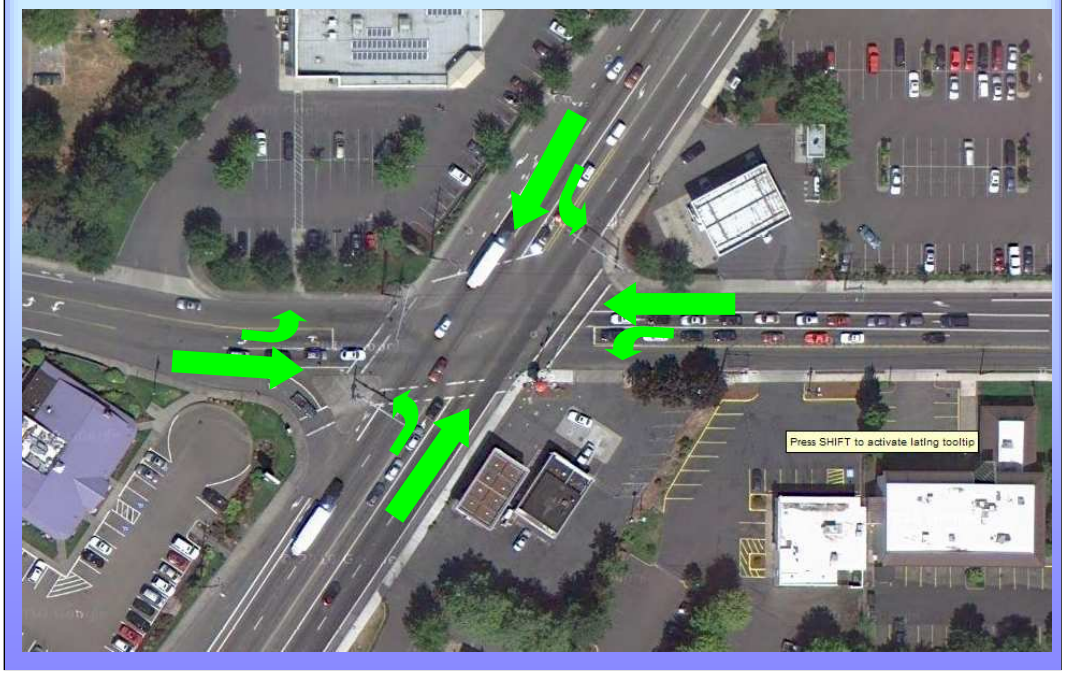
Dynamic Phase Reversal - normal



What do drivers notice – The side street left-turn phase that is served first is determined by detector data as opposed to current phasing where the order is always going to be the same.

Decision Criteria - Need to have appropriate geometry with a protected left-turn lane. If this feature is activated, the controller makes the decision with each cycle as to whether to use the feature for each cycle.

Dynamic Phase Reversal - reversed



What do drivers notice – The side street left-turn phase that is served first is determined by detector data as opposed to current phasing where the order is always going to be the same.

Decision Criteria - Need to have appropriate geometry with a protected left-turn lane. If this feature is activated, the controller makes the decision with each cycle as to whether to use the feature for each cycle.

Dynamic Phase Reversal

Benefits

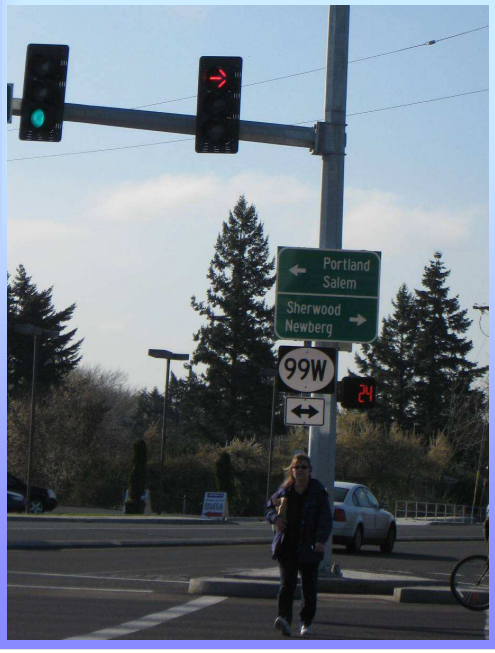
- More effective clearing of side street queues

Drawbacks

- May violate driver expectancy
- May violate pedestrian expectancy at split phased intersections

Benefits/Drawbacks – Benefit is more effective clearing of side street queues. The potential drawback is that it might violate both driver and pedestrian expectancy. This is particularly a concern for sight-impaired pedestrians, especially at split-phased intersections because the ped phase runs with both of the side street phases and the leading phase would not always be the same.

Not Ped Overlap



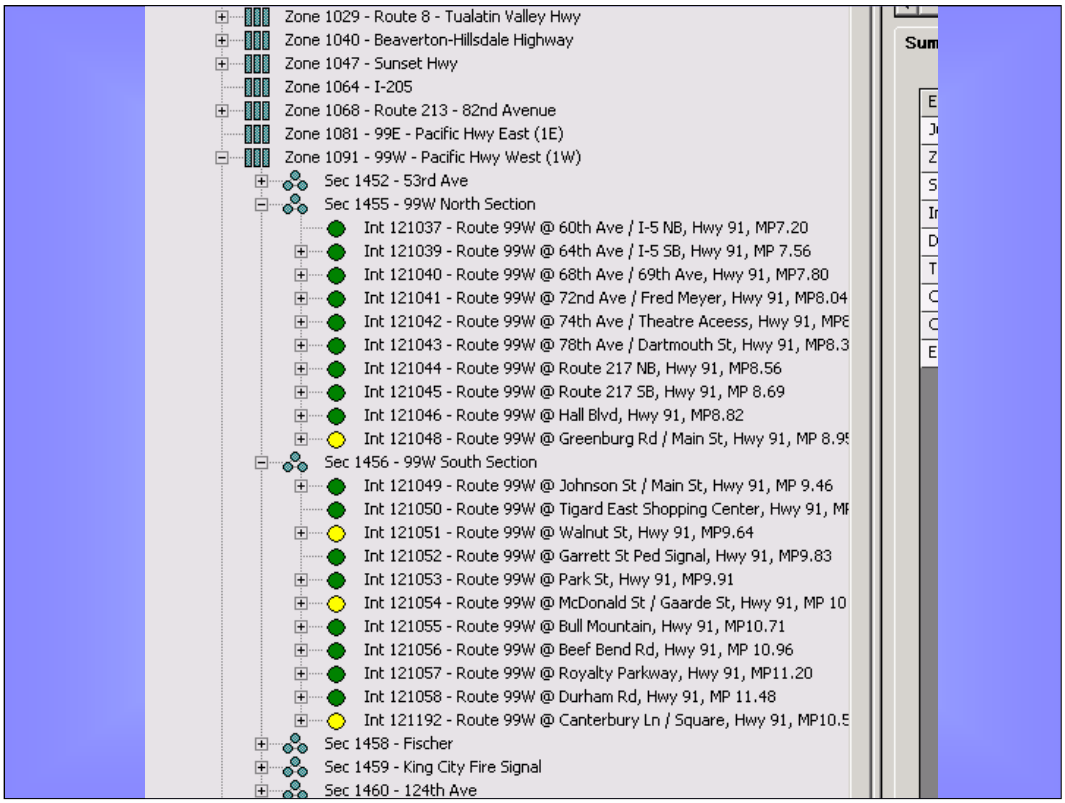
- Typically a right-turn lane that operates with the mainline left-turn and the side street through
- Replaced a five-section head with arrows and balls
- Red arrow with pedestrian movement
- Green arrow when no pedestrian

Not Ped Overlap – Honorable mention, since the County's Hall/Greenburg project installed right-turn phasing on the side streets which allowed us to utilize this feature. This is allowable under Oregon law since right-turns on red are allowed even on an arrow indication.

TransSuite

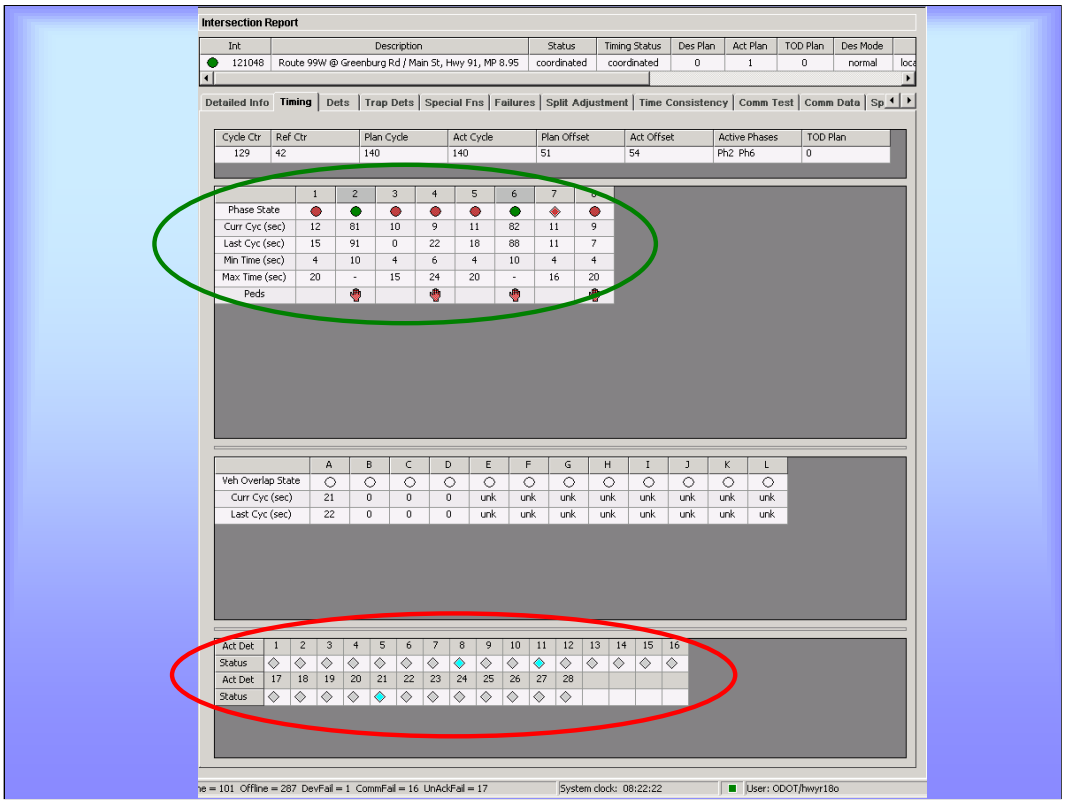
Differences between Voyage and TransSuite

- Voyage is the program that runs the individual intersections. It runs in a box called a 2070 controller. Think of the controller like a computer (Dell or HP or whatever) and Voyage like Windows running on that machine.
- TransSuite is a central system that talks to all the controllers. Think of the controllers as a group of engineers, each working on their own projects. TransSuite would be like their manager, whom they report to and who keeps an eye on them (some to more scrutiny than others).



Live Demo of TransSuite – made up of a variety of programs with a lot of abilities

Mgmt UI – allows us to see the status of entire systems at a glance



Timing tab – shows detail about which directions are green (and for how long) and which detectors are active

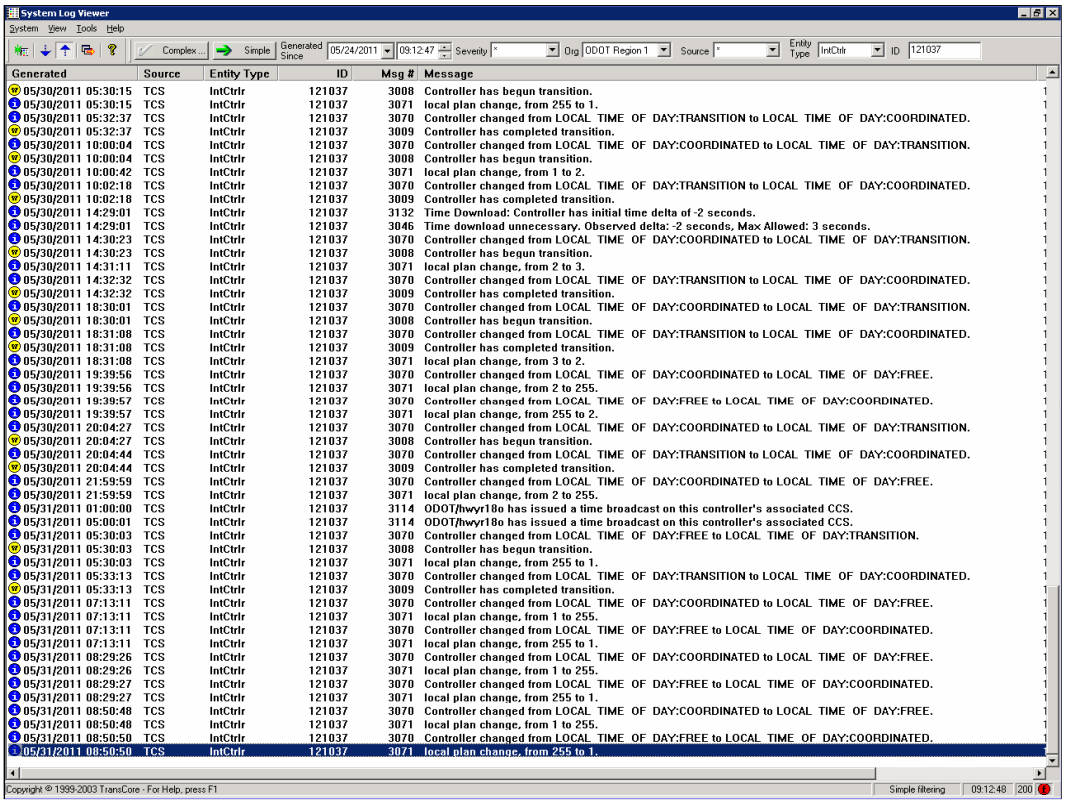
Useful in responding to citizen calls

UCM

- Timing database management
- Get and send timing to the controller remotely

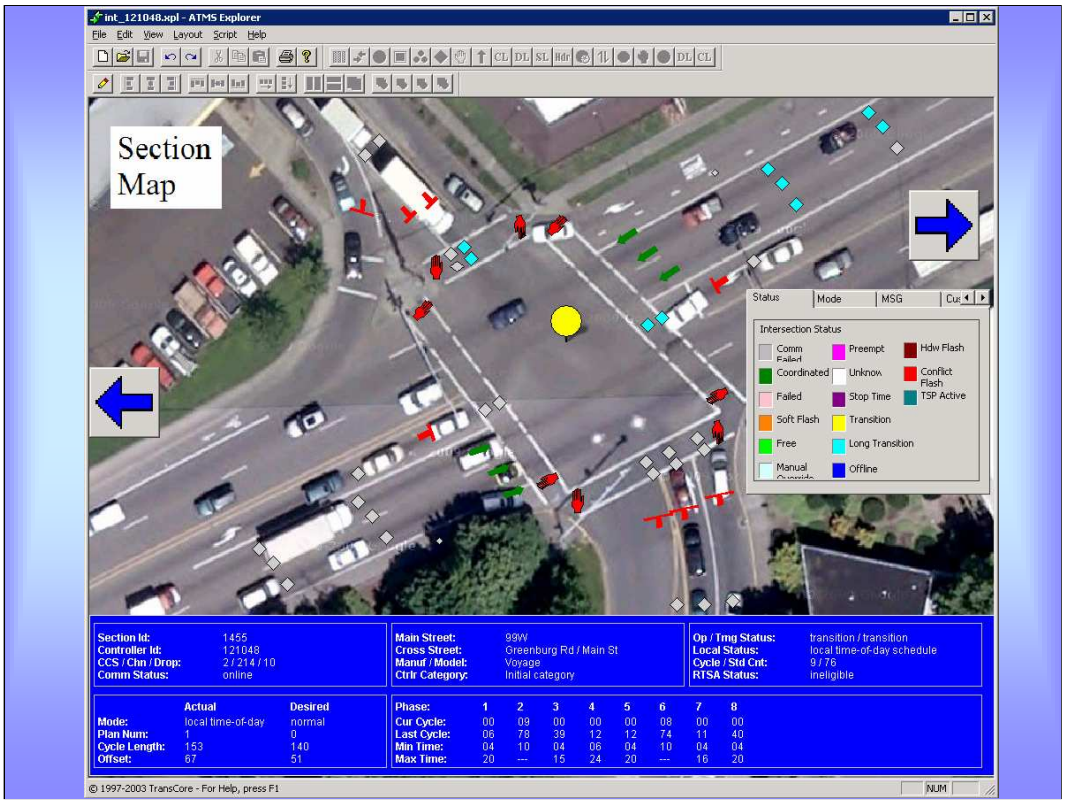
121046	99W	Hall Blvd	Voyage	121046	99W@Hall Blvd	
121047	99W	Fischer Rd	Voyage	121047	99W@Fischer Rd	
121048	99W	Greenburg Rd / Main St	Voyage	121048	99W@Greenburg Rd / Mai	
121048.2	Wapiti Mimic			Created: 2009-09-10 09:59:21.477	Saved: 2011-03-09 15:47:57.097	
121048.3	Advanced			Created: 2009-11-17 13:04:36.73	Saved: 2011-04-14 16:43:07.987	
121048.5	Optimized Wapiti mimic	8 phase		Created: 2010-08-31 08:55:21.86	Saved: 2011-03-18 16:39:23.02	
121049	99W	Johnson St / Main St	Voyage	121049	99W@Johnson St / Main S	
121050	99W	Tigard East Shopping Center	Voyage	121050	99W@Tigard East Shoppi	
121051	99W	Walnut St	Voyage	121051	99W@Walnut St	

UCM – timing database management (get/send timing to controllers). Allows multiple versions of the timing for each intersection, which was huge for this project.



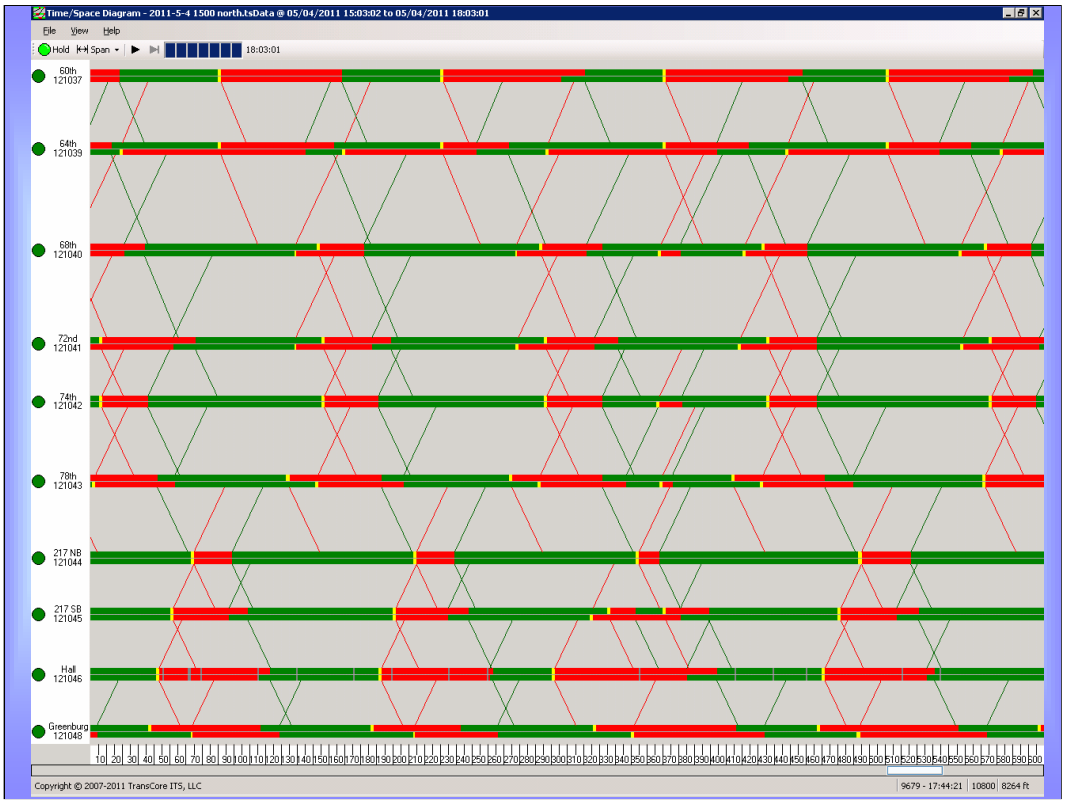
System Log Viewer – records every event that happened at a controller. Can be filtered to find specific events or time/date ranges

Useful in responding to citizen calls



ATMS Explorer – shows live graphic of intersection with directional greens and detection

also use hyperlinks to get to other signals in the system



Time/Space Diagram – Live representation of the greens traveling through a corridor. Similar to Synchro, so we used it to make sure our plans were matching the model

Preliminary Results

- Morning travel time consistently improved
- Mixed results at other times of day
- Expectation of slightly increased travel time combined with reduced queues on minor movements

Final evaluation is not yet complete. Kittelson is working on it, but we have a few preliminary results

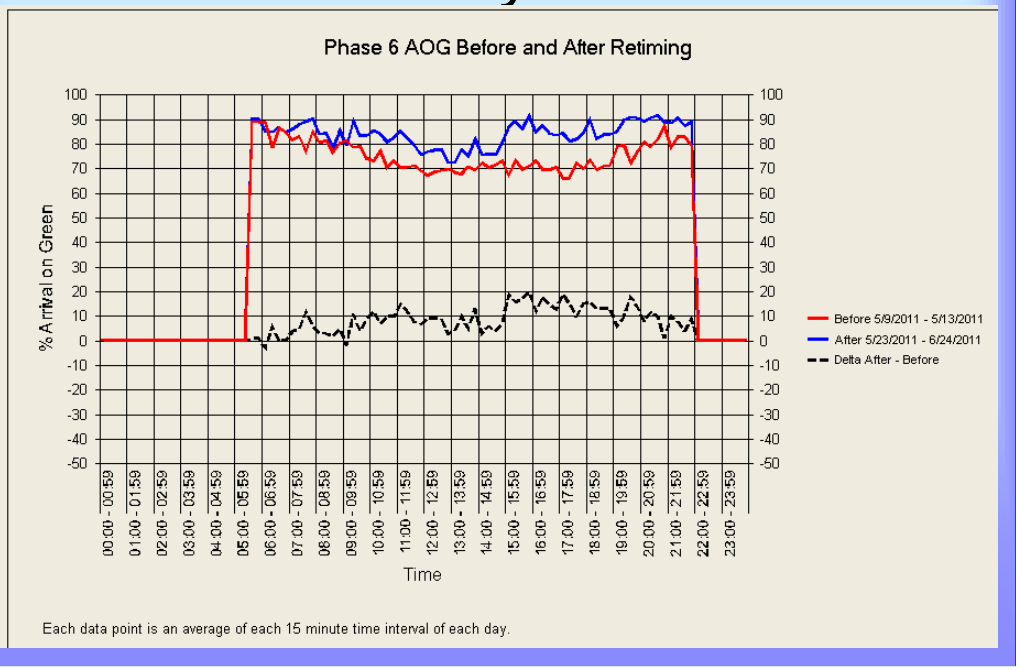
The travel times processed so far consistently show improvement in the AM

Primarily due to adding 20 seconds per cycle to 99W

Travel times for other times of day sometimes show increased and sometimes show decreased travel times, depending on the length of evaluation time, direction, and time of day. Further data processing will hopefully make sense of this data.

We do expect to see a small increase in travel time that is balance by reduced queues on the minor movements. The queue study is not completed yet to show the complete picture.

Preliminary Results



This graph shows arrival on green. This compares the number of vehicles arriving on a green light versus arriving on a red light. The red line is before timing changes and the blue line is after the timing changes. As you can see, the percentage went up at this location, indicating that fewer vehicles are stopping.

Lessons Learned

- Comprehensive office testing is crucial
- Field operation of new features must be monitored after implementation
- Document testing process
- Some features don’t play well with others

Comprehensive office testing is crucial

More complicated than we’re used to, so we had to know what we were putting out there.

Field operation of new features must be monitored after implementation

Despite our best testing, sometimes certain combinations of detection caused unexpected things to happen.

Document testing process

In finding and solving issues, it’s important to document so that we don’t have to repeat the same problems.

We are currently preparing documentation for each signal with these types of problems and solutions

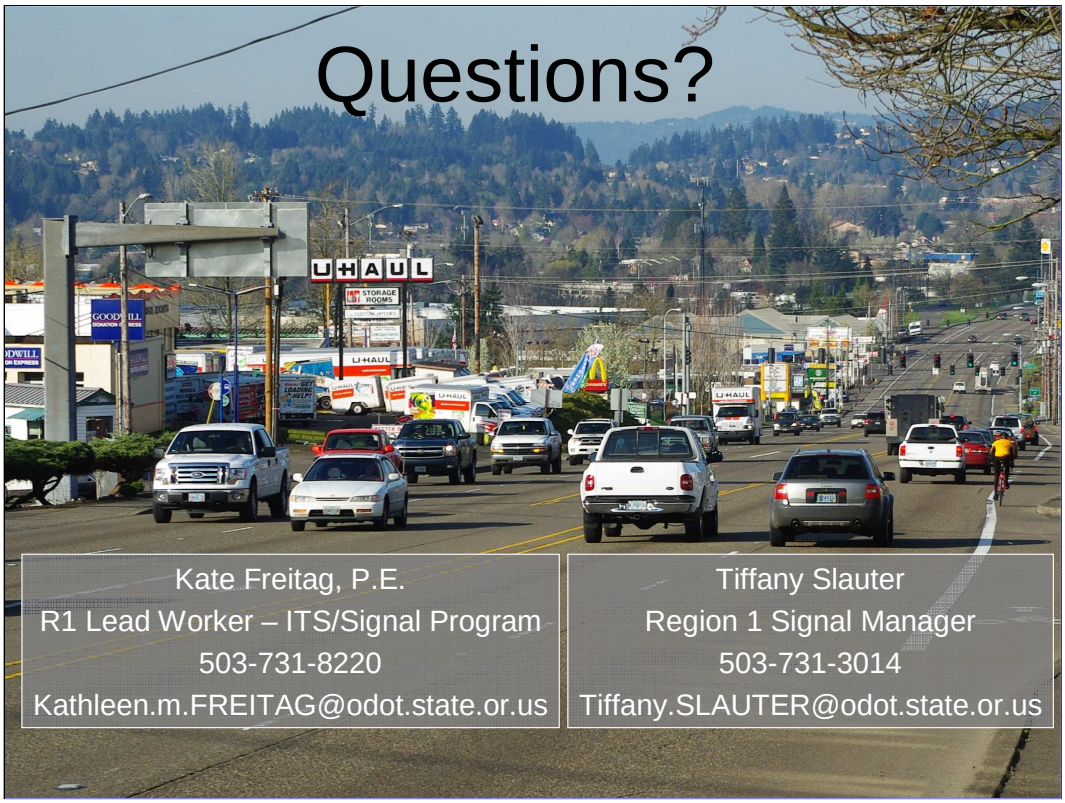
Some features don’t play well with others

But those problems can often be mitigated with a few tweaks!

Next Steps

- Final evaluation report
- Document lessons learned
- Continue to monitor corridor
- Document advanced features used
- Create responses to anticipated driver concerns
- Continue learning about the software and applying that knowledge

Kittelson's evaluation is due at the end of 2012. The evaluation for this project was folded into one contract with 10 other similar evaluation projects. The evaluation for our project will likely be done sooner than that, but doesn' have to be.



Questions?

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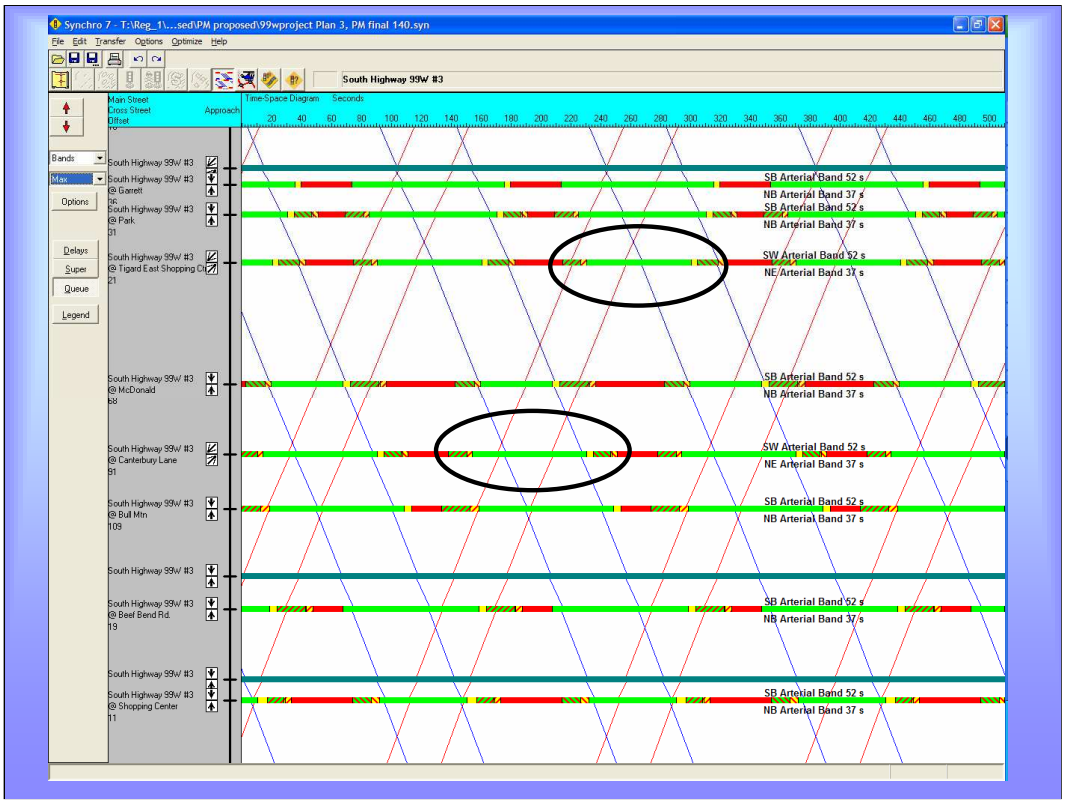
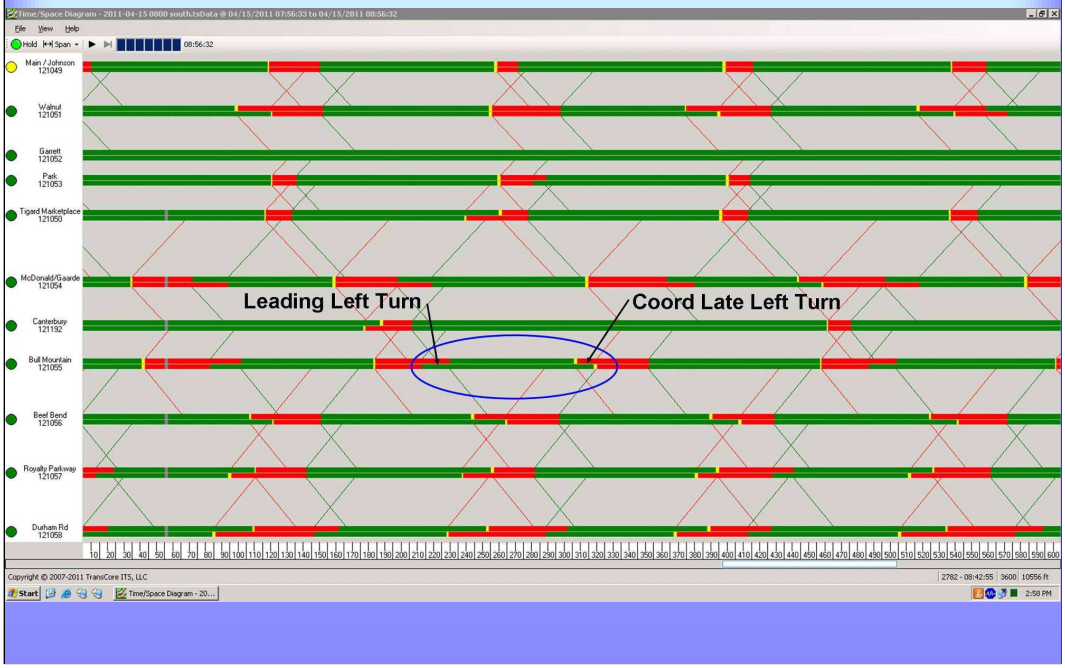
Additional Graphics



With actuated coordination and coord late left, careful examination of the time/space diagram is crucial to know if you can shave off time from a coordinated phase or make a left turn phase lead (for CLL).

For instance, Tigard East Shopping Center couldn't be switched to lead/lag, but Canterbuy could. Though both of them could do actuated coordination on one or both phases.

Coord Late Left Turn